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*Centro Nacional de Supercomputación*



**EXCELENCIA  
SEVERO  
OCHOA**

# Earth System Services (ESS)

Marta Terrado - Science  
Communication Specialist

December 2017

Earth Science Department, BSC-CNS

# Barcelona Supercomputing Center

Research, develop and manage information technology  
and facilitate its application in the society

Created in  
**2005**

**550**  
employees

MareNostrum 4

**PRACE**  
network

**50,000** Cores    **100,8** TB main memory    **3** PB disk storage

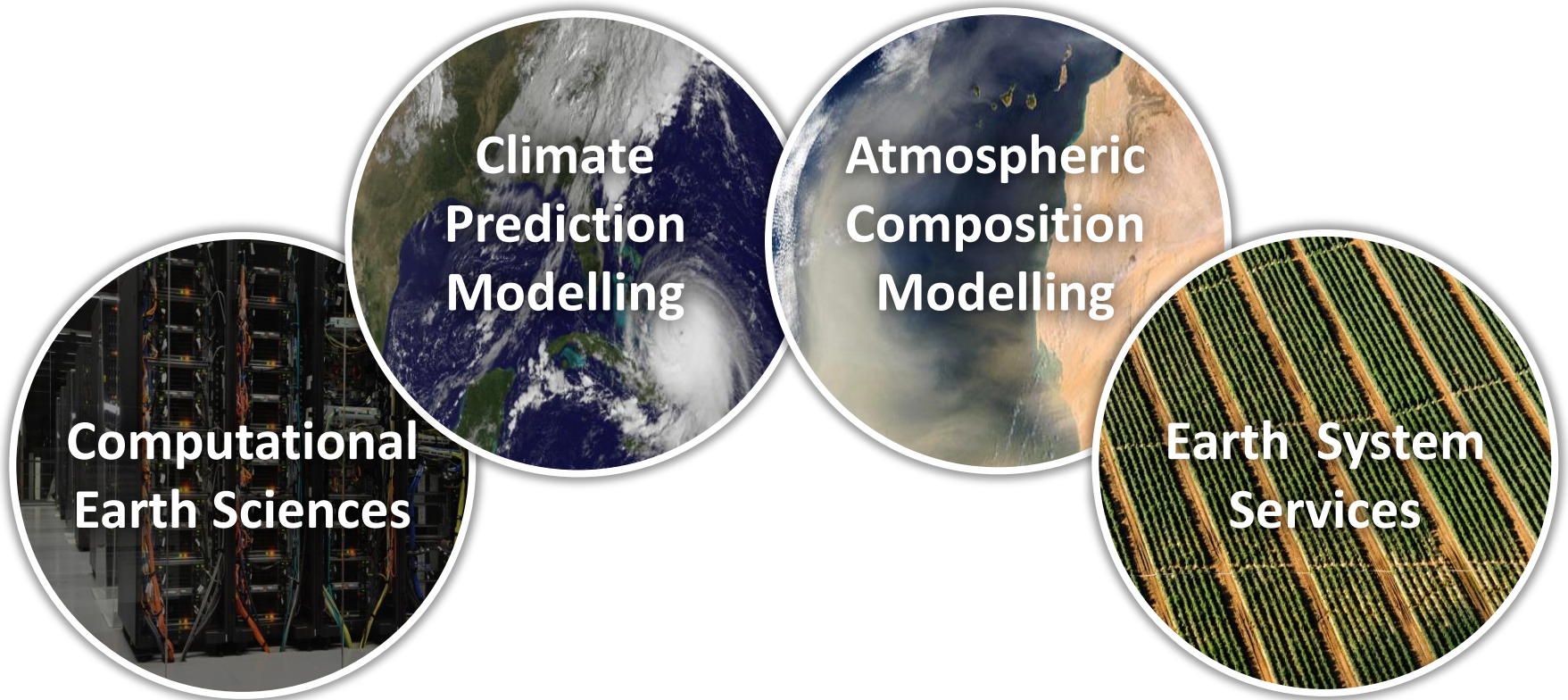


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# Earth Science Department

Environmental modelling and forecasting, with a particular focus on weather, climate and air quality



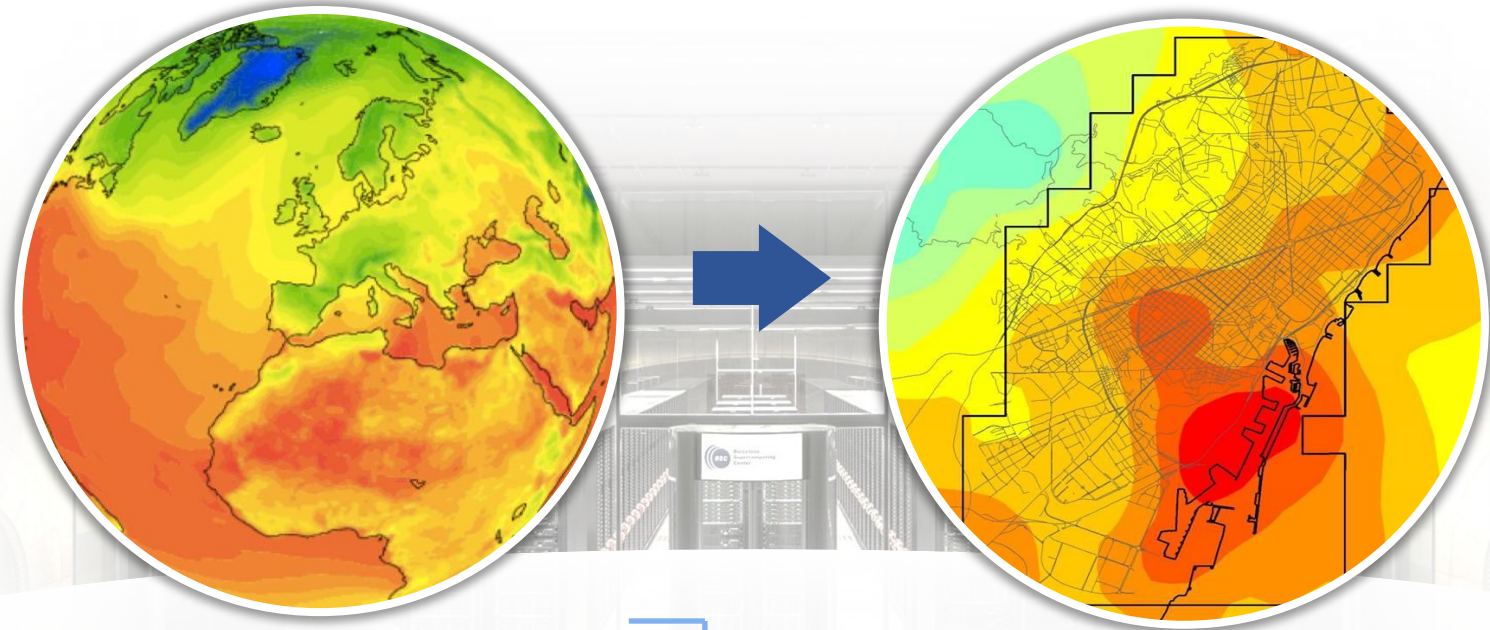
# Climate and Air quality modelling



**From the real world  
to models**

- Earth Observations
- Physical processes modeled on a gridded Earth (Latitudinal, Longitudinal and Altitudinal)
- Final model predictions

# Spatial scales

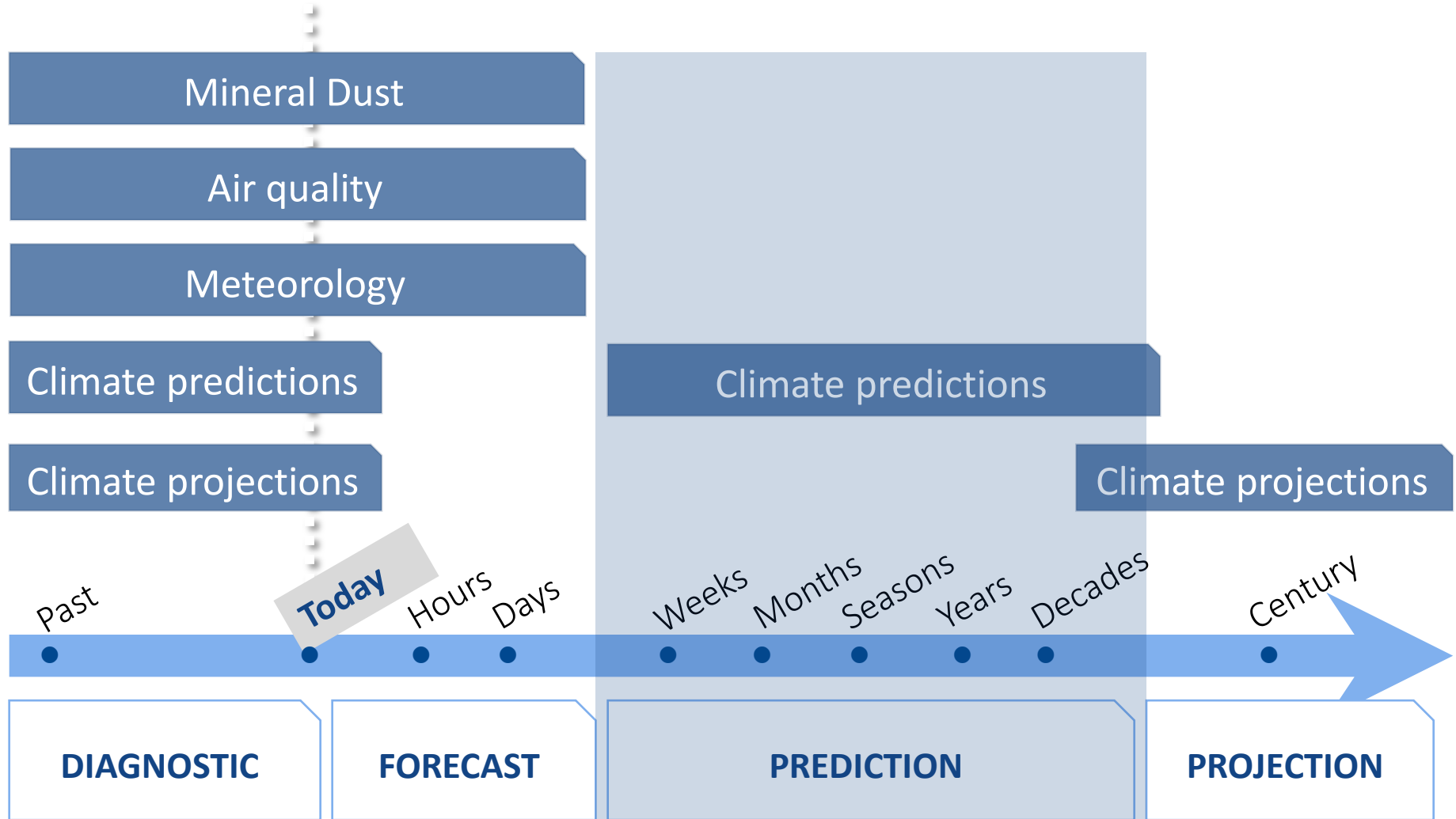


**Multi-scale  
models**

- Global
- Regional
- Local



# Temporal scales



# Predictability

How can we predict climate for the coming season if we cannot predict the weather next week?

## Weather forecasts

The forecasts are based in the initial conditions of the **atmosphere**, which is highly variable and develops a chaotic behaviour after a few days

## Climate predictions

The predictions are based in the initial conditions of the **sea surface temperature, snow cover or sea ice**, which have a slow evolution that can range from few months to years

The Earth System Services group facilitates **technology transfer** of state-of-the-art research from local, national and international levels





# Multidisciplinary team at ESS



**Albert Soret**

Coordinator;  
Chemistry



**Sara Basart**

Post-Doc



**Marc Guevara**

Post-Doc



**Dani Rodríguez**

PhD student



**Jaime Benavides**

PhD student



**Miti Mishra**

PhD student



**Nube Gonzalez**

Post-doc



**Nicola Cortesi**

Post-Doc



**Raül Marcos**

Post-Doc



**Andrea Manrique**

Post-Doc



**Verónica Torralba**

PhD student



**Llorenç Lledó**

PhD student



**Isadora Jiménez**

Communication  
specialist



**Marta Terrado**

Communication  
specialist



**Dragana Bojovic**

Social scientist



**Amaia Aizupur**

Web Developer



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# From Research to Services

[www.bsc.es/ess](http://www.bsc.es/ess)

## Agriculture



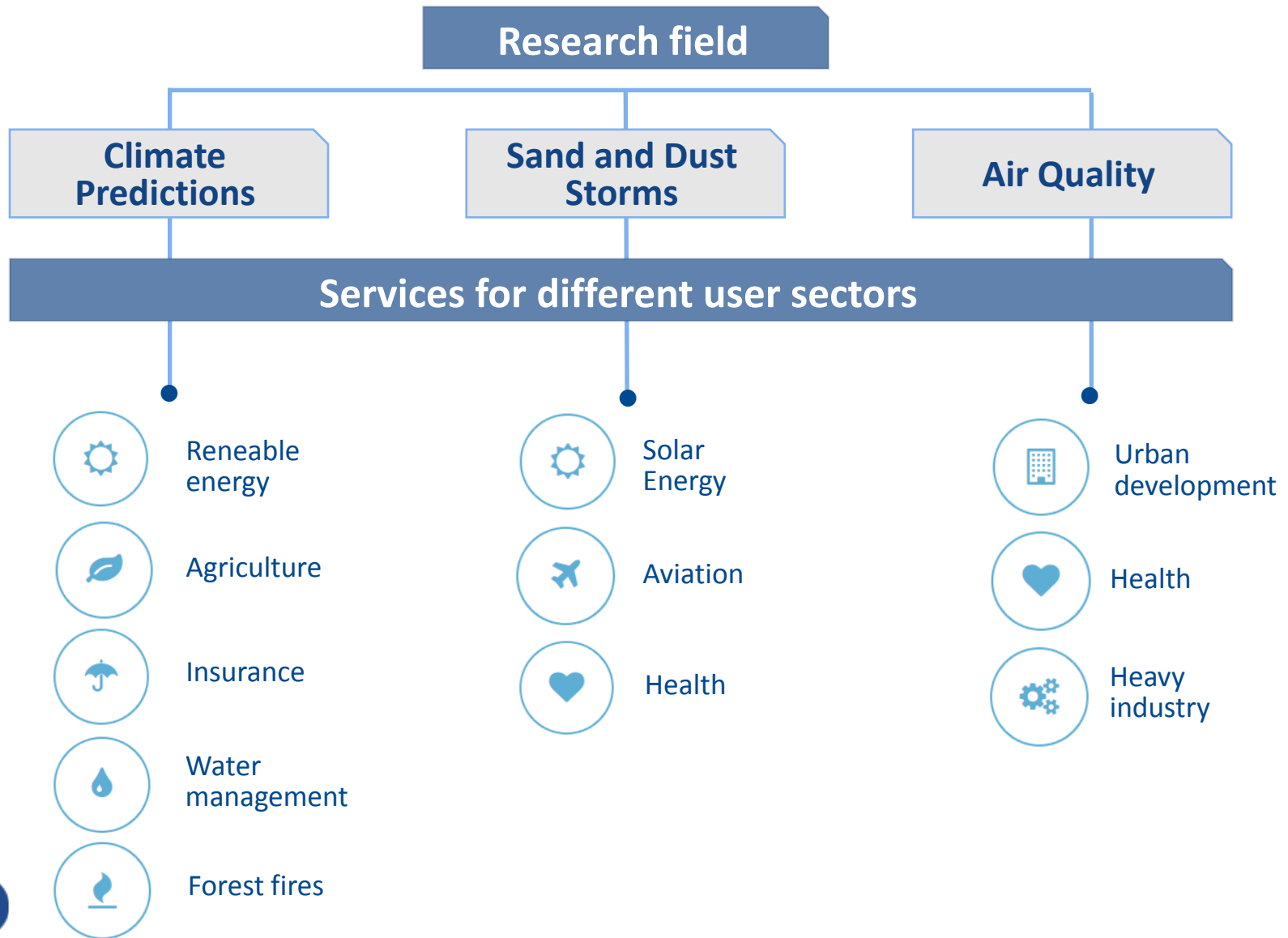
Few businesses are as dependent on the weather as farming. Variables such as temperature, precipitation or wind speed are key for agricultural production, affecting every aspect in the management of agricultural operations. Applying High Performance Computing (HPC), the BSC produces climate information and services useful for the agricultural community. This information can be used to support your decision-making during the crop phenological cycle and to guarantee an optimal production in the face of current and future climate variability.

[Sub-seasonal to seasonal predictions](#)

[Decadal predictions](#)

[Climate projections](#)

# From Research to Services





# From Research to Services

*Case studies for specific needs*



*Participatory approaches*



Scientific  
user-driven  
research

Users

User  
engagement

*Industrial partners*



*Research centres*



*Administrations*



*International  
organisations*



*Meteorological  
Centers*



# From Research to Services

## Seasonal Forecasts for Wind Energy



### Wind bulletin - Winter 2015/16

#### How will wind speed vary in the next season?

It is currently uncertain how wind resources will vary from one season to the next. For this reason, estimating the change in wind speed in the next season is a challenge for wind energy users. Information of the average wind speed in the upcoming season can support the wind energy sector when taking decisions on energy production, as well as other management actions, ahead of time.

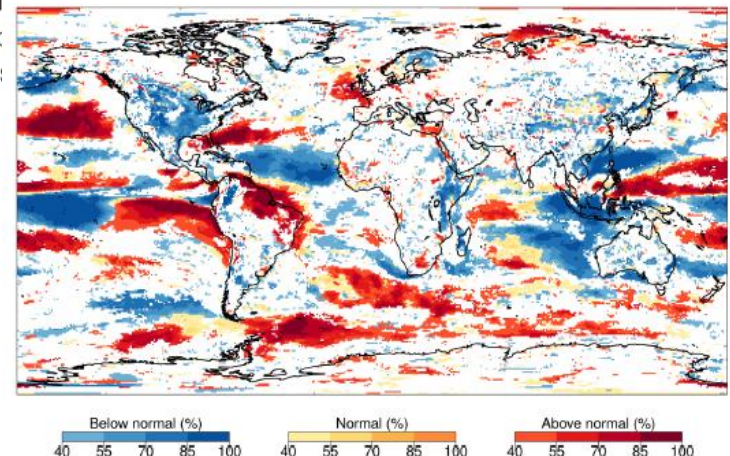
Seasonal wind predictions provide information on the probability that the seasonal wind speed will be above, near or below normal. They indicate the most likely tercile category (above, near or below normal) of the predicted surface wind speed. To assess the level of confidence that can be given to a particular prediction and decide whether to use it in the decision-making process, it is essential to compare how well wind speed can be predicted against the ob-

served climatology (years **1981-2014**) for the same target season over as many years in the past as available (quality assessment).

This newsletter issues the winter season prediction that could have been made available at the beginning of November 2015 for December, January and February 2015/16, and compares it to observations of what actually happened. The aim is to demonstrate whether state-of-the-art climate forecasting can assess the seasonal variability of wind.

The added value of seasonal climate prediction by quantifying to which extent the economy using climate predictions outperform the one of the long term in areas where the model has (see [Factsheet #6](#)).

#### Global prediction of wind speed



# Research lines: Climate predictions



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# Climate predictions for agriculture



- Agriculture is one of the sectors that will be most impacted by current climate variability and future climate change
- Having climate information in advance can help **optimise decision-making processes** that will allow to **minimise crop losses** and **preserve/enhance the quality** of the final product

# Climate predictions for agriculture

## Medium-term time scale

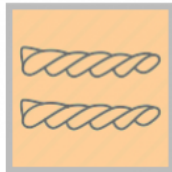
### MANAGEMENT DECISIONS



- *When and where should we apply pesticides to control the olive fly pest in the next campaign?*



- *How many pest spray treatments are expected from the upcoming spring/summer season?*



- *What is the expected schedule for the application of fertilizers?*

## Long-term time scale

### STRATEGIC DECISIONS

- *Which will be the average productivity (olive yield) in a certain region in 10-20 years?*

- *Will the variety that we plant today be able to continue to resist in the future?*

- *What new areas will be suitable for durum wheat cultivation in the next future?*

# Climate predictions for water management

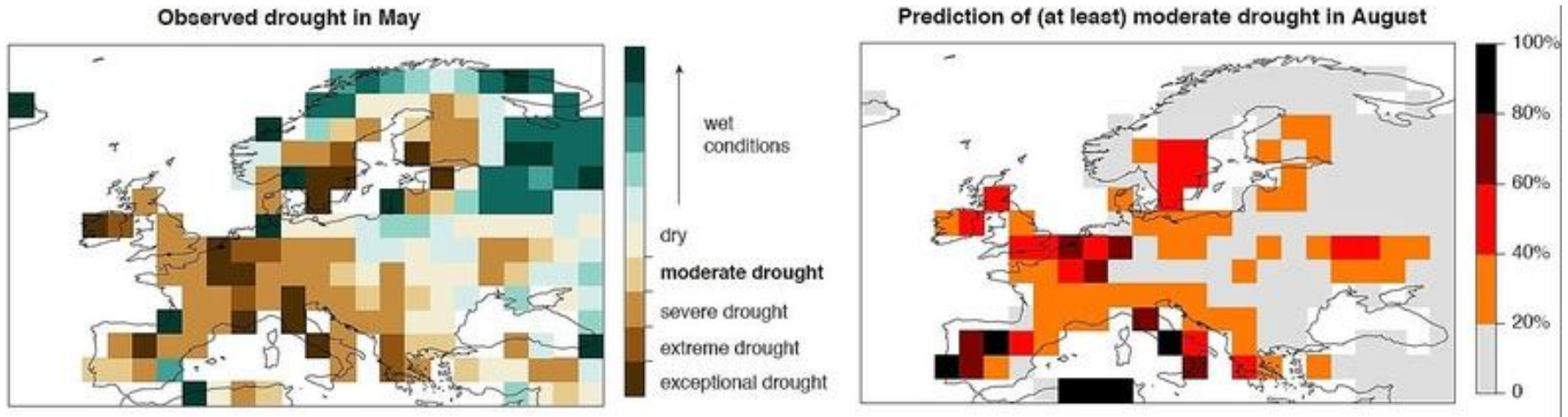


- Floods and droughts cause huge social and economic damage. Their frequency and magnitude is likely to increase in the coming years as a result of climate change
- Improving hydrological predictions will be useful for the **management of hydrological extremes** and their **impact on water reserves, agriculture and even forest fires**



# Climate predictions for water management

## DROUGHT PREDICTION



*Category of drought observed in May 2017 in Europe (left) and prediction of the probability of moderate to exceptional drought in August 2017 (right). Source: Turco et al. (2017)*

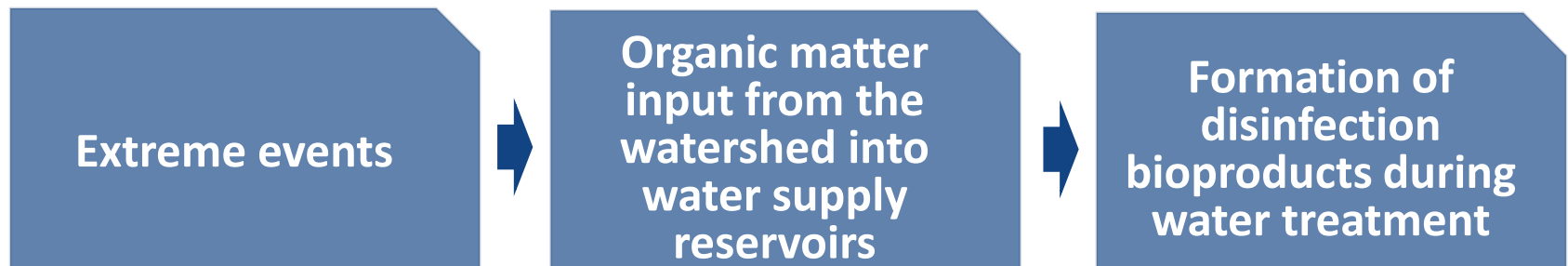
Systems used had predictability with 4-5 months lead time



**Food production**  
**Water supply**

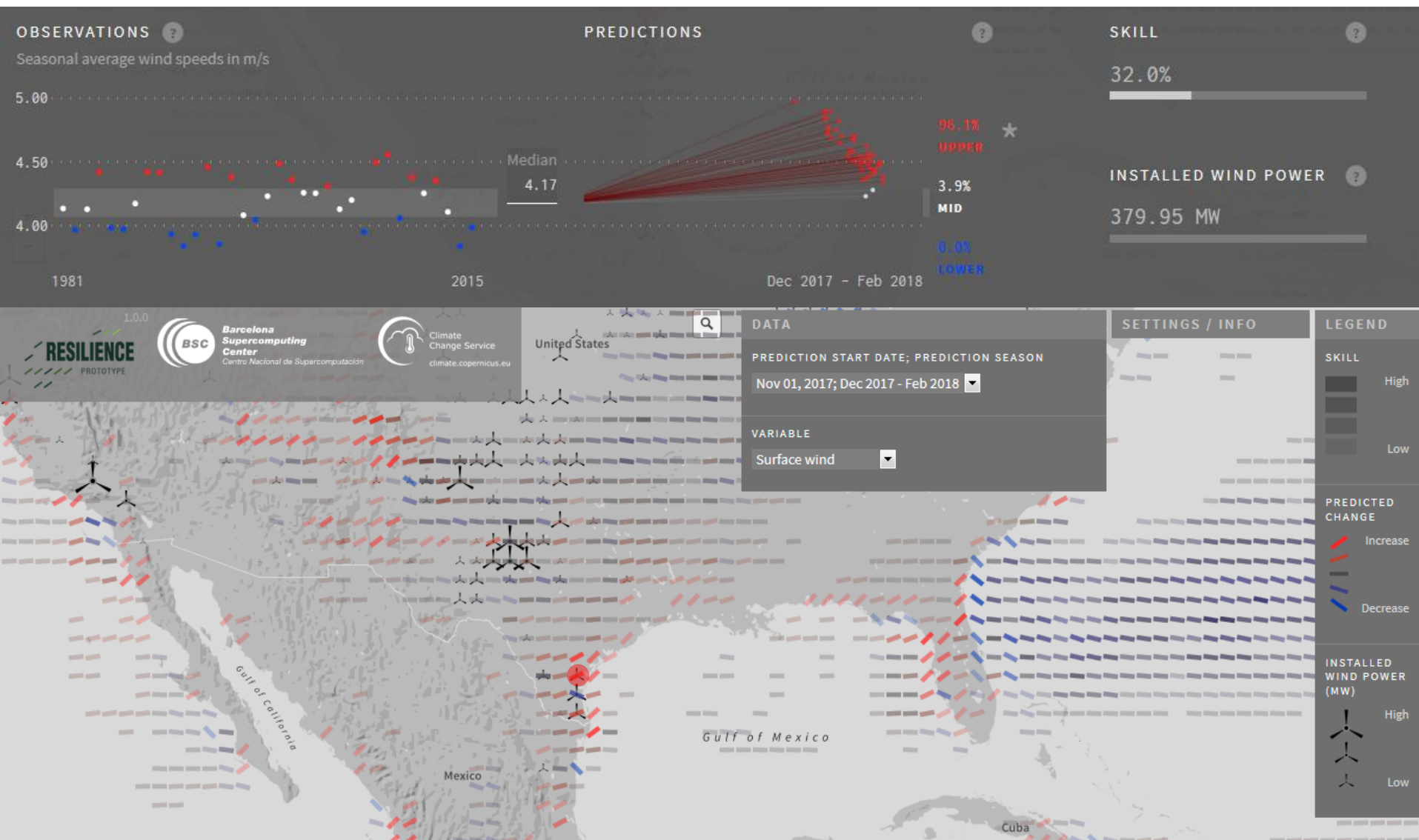
# Climate predictions for water management

## EXTREME EVENTS PREDICTION (P)



Potential application of **seasonal climate predictions** for protecting the **water supply ecosystem service** through the management of water quality during extreme events

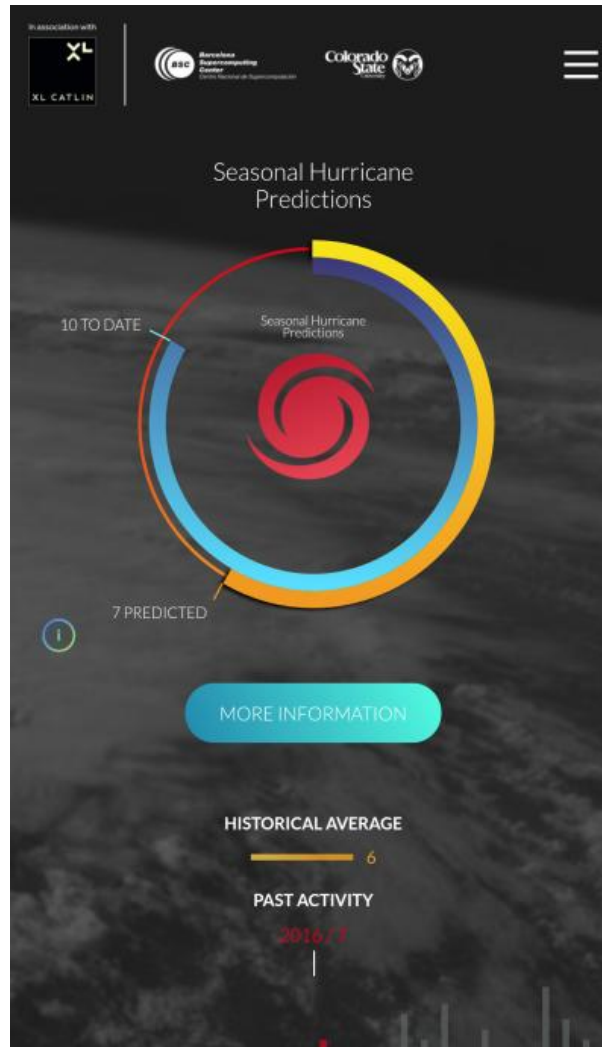
# Climate predictions for wind energy





# Climate predictions for the insurance sector

[www.seasonalhurricanepredictions.org](http://www.seasonalhurricanepredictions.org)



Platform that brings together predictions from different centers that specialize in Atlantic hurricane forecasting

# Research lines: Sand and Dust Storms



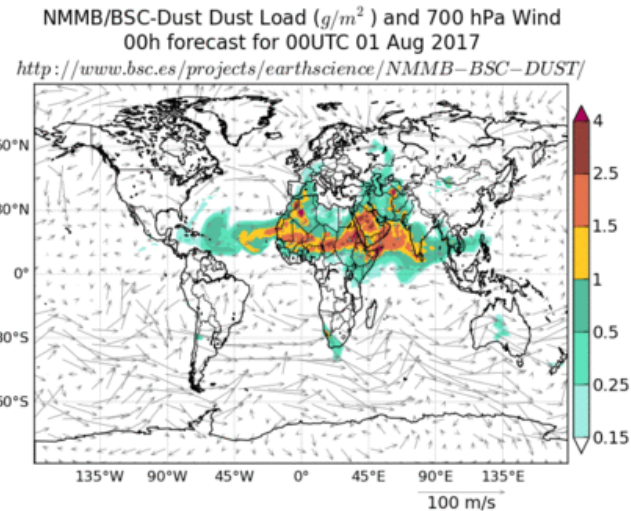
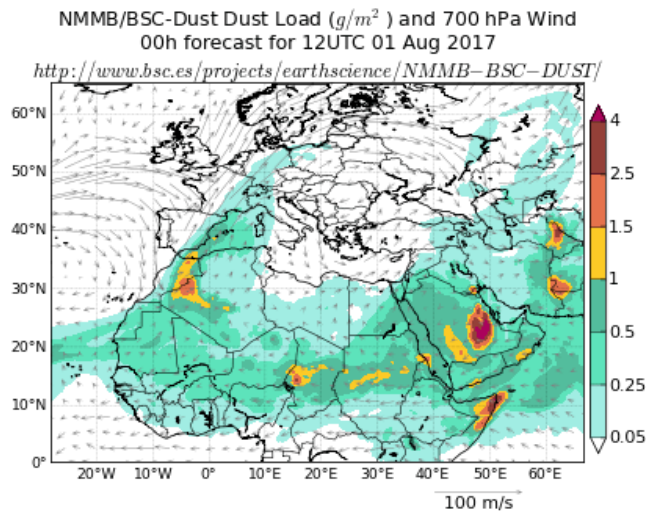
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# Mineral Dust Services

BSC Dust Daily Forecast

[www.bsc.es/ess/bsc-dust-daily-forecast](http://www.bsc.es/ess/bsc-dust-daily-forecast)



## Applications





# Research lines: Air Quality



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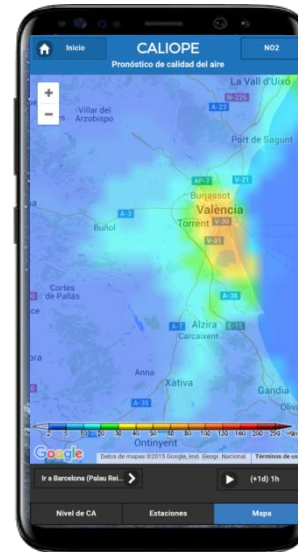
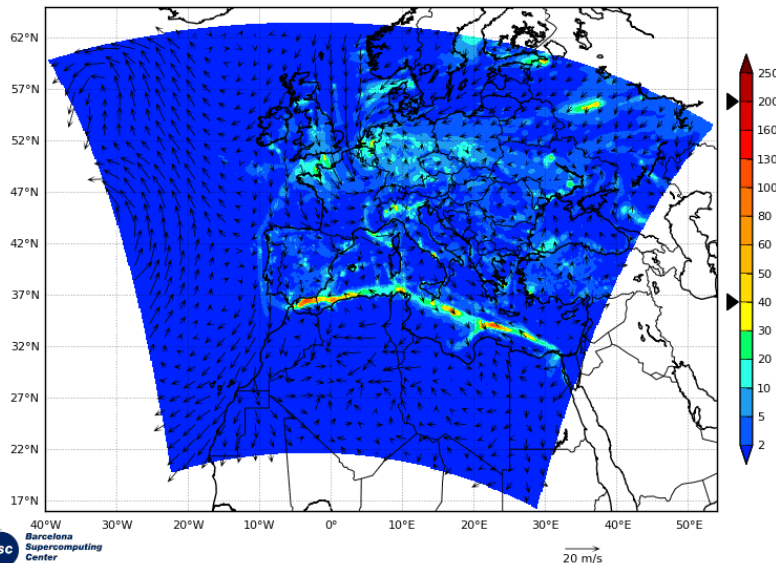


# CALIOPE

[www.bsc.es/caliope/](http://www.bsc.es/caliope/)

- Operational air quality forecasts for the next 48h for major regulated pollutants (NO<sub>2</sub>, SO<sub>2</sub>, O<sub>3</sub>, CO, PM<sub>10</sub>, PM<sub>2.5</sub>) – Europe, Spain, Catalonia
- Meteorological model (WRF) + **Emissions model** (HERMES) + Chemistry model (CMAQ) + Dust transport model (BSC-Dream8bv2)

BSC-ES/AQF WRFv3.5.1+CMAQv5.0.2+HERMESv2 Nitrogen Dioxide ( $\mu\text{g}/\text{m}^3$ )  
00h forecast for 00UTC 31 May 2016 - Europe Res: 12x12km



## APPLICATIONS



HEALTH alerts to anyone interested in the state of air quality (people with cardio-respiratory diseases, small children, runners)



HEAVY INDUSTRY integrated assessment and control of point pollution sources (power, incineration or biomass plants, cement industries)

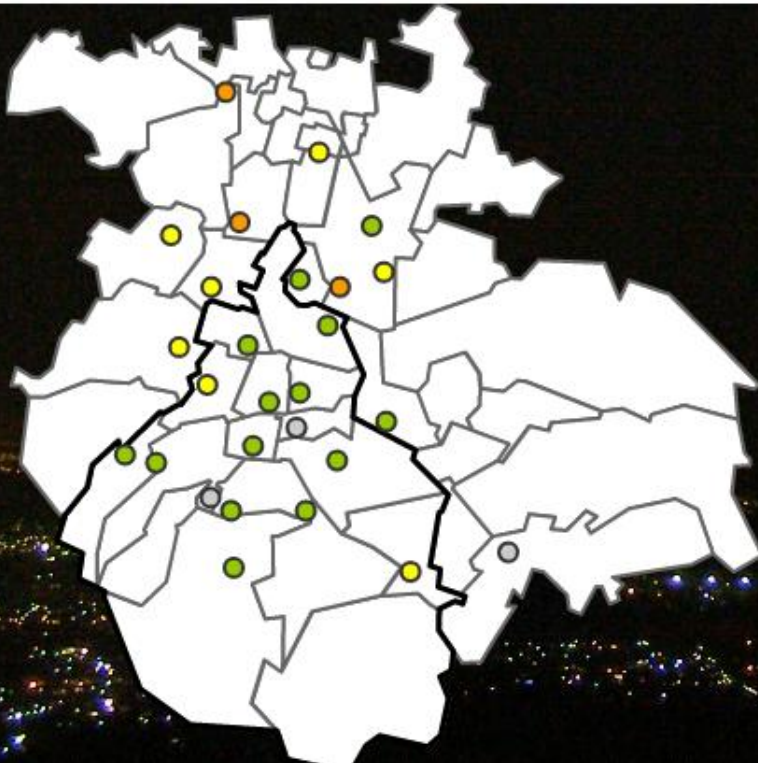


URBAN PLANNING of the effect of management strategies to reduce atmospheric pollution and effects on citizens and the environment

# Air quality forecast system for Mexico FD

[www.aire.cdmx.gob.mx](http://www.aire.cdmx.gob.mx)

- CALIOPE **knowledge & technology transfer** to the Secretary of Environment of Mexico FD (meteorological model + emissions model + air quality model)



● BUENA ● REGULAR ● MALA ● MUY MALA ● EXTREMADAMENTE MALA ○ MANTENIMIENTO

Ciudad de México, Sábado 16 de diciembre de 2017

🕒 19 horas 🌡️ 17 °C

Calidad del aire: ● MALA

Contaminante: PM<sub>10</sub>

Índice: 105

Estación: XAL-Xalostoc

Recomendaciones aire:

Recomendación UV:



ÍNDICE UV  
0

NO NECESITA PROTECCIÓN

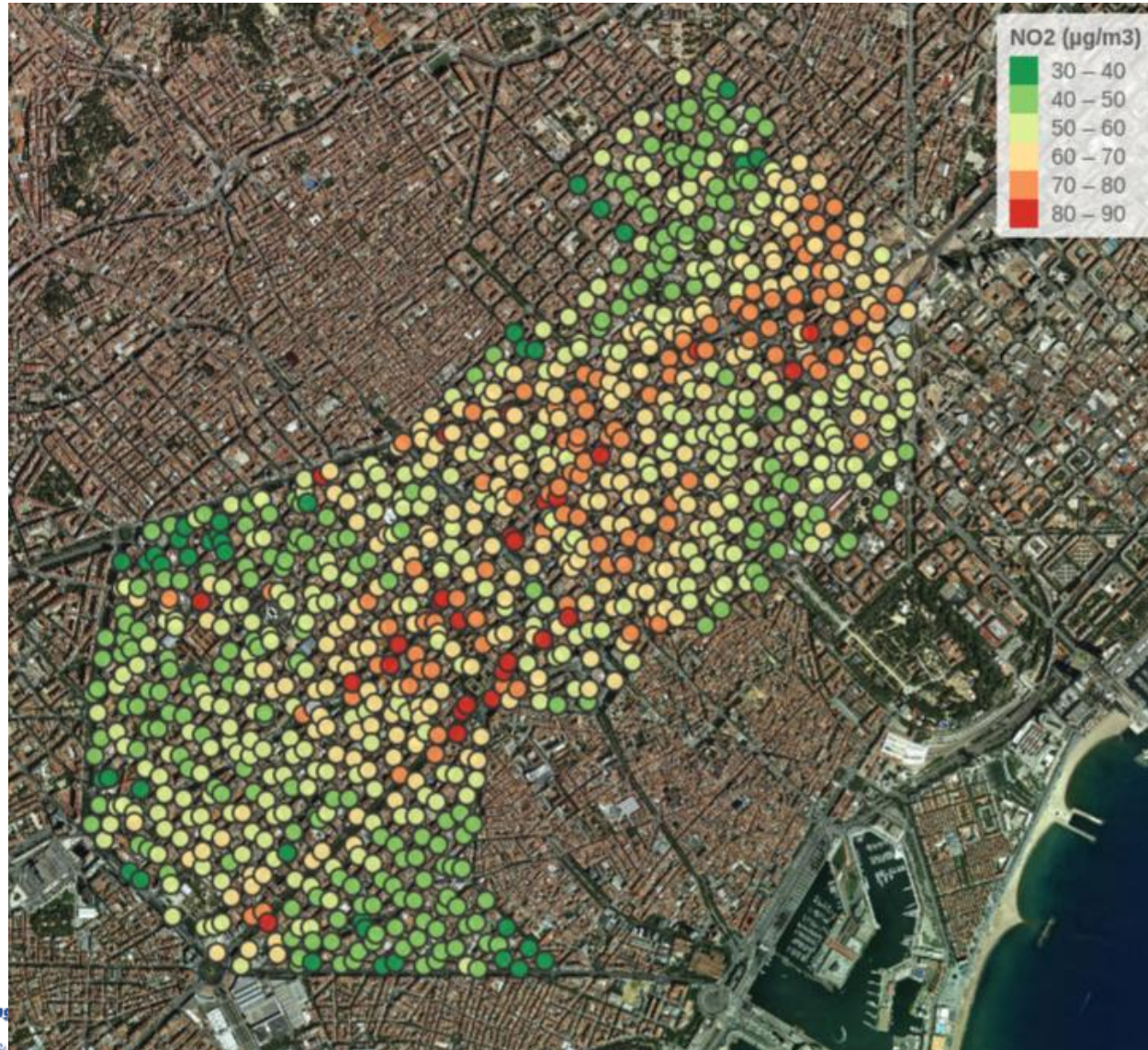
Hoy no circulan: H1 **Impar** H2 **Todos**

Este mes verifican:






# CALIOPE urban



# Ecosystem services in urban environments

## Health and climate related ecosystem services provided by street trees in the urban environment

Jennifer A. Salmond , Marc Tadaki, Sotiris Vardoulakis, Katherine Arbuthnott, Andrew Coutts, Matthias Demuzere, Kim N. Dirks, Clare Heaviside, Shanon Lim, Helen Macintyre, Rachel N. McInnes and Benedict W. Wheeler

*Environmental Health* 2016 **15(Suppl 1)**:S36

<https://doi.org/10.1186/s12940-016-0103-6> | © Salmond et al. 2016

Published: 8 March 2016

### Abstract

Urban tree planting initiatives are being actively promoted as a planning tool to enable urban areas to adapt to and mitigate against climate change, enhance urban sustainability and improve human health and well-being. However, opportunities for creating new areas of green space within cities are often limited and tree planting initiatives may be constrained to kerbside locations. At this scale, the net impact of trees on human health and the local environment is less clear, and generalised approaches for evaluating their impact are not well developed.







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# THANK YOU!

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# Synergies

- Possible integration of **climate/air quality services & ecosystem services** at the medium-term management time scale? (seasonal, annual...)

*There are studies that look at projections to estimate the provision of climate services in 30-years time (more strategic decisions)*

- Do you think it would be helpful to have climate/air quality forecasts in advance to advice a decision-making that optimizes the provision of particular ecosystem services?

# Temporal scales

(a)

